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1. Prior to World War II, technical development in the Soviet boiler industry was slow and most of the existing enterprises belonged to foreign firms. Although there were a few Soviet boiler manufacturing firms in the USSR at that time, such as Putilov and Obukhov in Leningrad, Kolomna Locomotive Factory near Moscow, Briansk Machinery Works near Orel, and the Government Ship Building Company at Nikolaev on the Black Sea, most boilers were imported from Germany and the UK.

2. Following World War II, the Heat-Technology Institute (Moscow Teplotechnickeskij Institute) was created in Moscow, for research in the utilization of fuels. Work was centered on the production of high-pressure steam, replacement of water by mercury, sodium, potassium alloys and volatile-organic substances, and fuel analysis. Many experiments were made with powdered fuels, then a novelty in the USSR, and on gas generators for mobile transportation in light of liquid fuel shortages. Benson, Lefleur and Schmidt-Hartmann boilers were carefully studied at this Institute as well. From 1929-1933, many of the technicians at the Institute were removed during the recurrent wave of terror, and all creative work came to an end. During this period, Professor Sergej Dzirictkij, one of the Institute's top researchers, disappeared for good. Following 1933, the Institute was re-organized, and work on foreign boiler investigation, chiefly of German design, began again.

3. From 1933 to 1941, vertical boilers were used largely in the USSR for small, mobile-power installations, such as cranes, elevators and excavators, while other countries were using electric and internal combustion motors; this was due to shortages of fuel and electrical know-how. Just prior to World War II, these vertical boilers, produced at such places as Kiev, Leninskaja Kusnia, and Kharkov Parovoso Remontnyj Zavod, were tried out on the chief railway lines such as

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the Leningrad-Moscow, Kiev-Kharkov and Moscow-Vladivostok, with no great success. Vertical boilers used were:

a. Shukhov Boiler - Vertical, with horizontal water tubes.

Height	=	3055 - 4550 mm.
Diameter	=	850 - 1350 mm.
Working Pressure	=	8 Atm.
Water Content per l/m^2	=	50 - 60 l. of heating surface (Galloway type.)

b. Vertical Fire-Tube Boiler - Heating surface of 10 - 40 m^2.

Height	=	1750 - 3600 mm.
Diameter	=	650 - 1500 mm.
Working Pressure	=	8 Atm.
Water Content per l/m^2	=	60 - 80 l. of heating surface.

This type was difficult to clean, and dangerous due to high water content.

c. Lancashire Boiler - USSR Standard -

A two fire-tube heating surface	=	100 square meters pressure of 10 Alt. maximum
Length of furnace grate	=	Not more than 2.0 - 2.4 meters
l/m^2 of heating surface	=	22-28 kgs of steam per hour
Surface of the evaporation mirror in ratio to the heating surface	=	0.22 - 0.3.
Floor surface per l/m^2 of heating surface	=	0.4 - 0.5.
Volume of the steam space per one square meter of heating surface	=	88 - 100 litres.

Furnace was placed inside the fire-tube, although outside furnaces were used for damp fuels such as peat. Fire-tubes were wave or smooth-fortified surfaced (Adamson type). If D is the diameter of the barrel of the boiler, and d the diameter of the fire-tube, then:

d = 0.5 D for one fire-tube boiler
d = 0.5 D - 250 mm to 300 mm for two fire-tube boilers.

Gases, after passing through fire-tubes, went around the barrel of the boiler, but in order to escape overheating of the steam-space in the upper part of the boiler, a steam superheater was placed immediately after the fire-tubes to cool the gasses.

4. The Putilov concern, Leningrad, built boilers with double heating; gases from two fire-tubes of the Lancashire type returned through the water by means of many thin fire-tubes. This combination of Lancashire boiler with fire-tube proved an economical space saver in boiler rooms, but was hard to clean due to the low ratio of the fire-tube section to the surface of the grate, equal to 0.12 - 0.13. The Lancashire type boiler was most predominant in Soviet industry prior to World War II, such as chemical and distillation factories (Vodka-Zavody) where power and steam were important elements.

5. In 1940, the Soviets carefully studied instructions from the German "Union of Owners of Large Water-Volume Boilers". Materials were gathered to build small, German-type, one fire-tube boilers, with heating surface equal to 15 - 50 square meters, and working pressure equal to 6 - 15 Atm, although no such boilers, to my knowledge, were ever actually produced.

6. Locomobiles and locomobile boilers, popular in the USSR during the World War I era, were still being built by the Krasnyj Kotelshchik concern in Kherson, and the Kolomna Locomotive Factory prior to 1941. Two types were most prevalent, both containing numerous fire-tubes with a furnace inside the boiler, the same as was used for locomotive boilers. These were pretty much copied after Wolf and Company, Magdeburg, and the German Lange boiler. Specifications were:

Diameter of fire-tube	=	45-60 mm.
Length " "	=	2000 - 2500 mm.
Acting surface of all fire-tubes	=	0.16 - 0.20 of the surface grate.

Superheaters, in large locomotives only, were placed in the smoke-box. In some later boilers, fire-tubes were shortened to 1400-1600 mm, in order to have hotter gases and a better superheating of steam.

7. Return-Tubular Boilers, copied from German-type Shiff Kessels, Melzer Betrieb, Halle, were made in large quantities in the USSR. They had reverse fire-tubes and an internal furnace, with a heating surface equal to 100 square meters. Used principally for river steamers, the hot gases from the furnace passed through the upper group of fire-tubes to the end of the boiler, then returned through the lower group of fire-tubes to the smoke-stack at the face of the boiler. Steamboats, complete with boilers, were built at the Leninskaja Kuznia factory in Kiev, then dismantled, loaded on trains, and sent to Vladivostok, where they were reassembled. Small gunboats were hastily built at this factory in 1940-1941, and sent to the Amur River and Vladivostok, despite publicity to the effect that the Far East was technically independent of European USSR assistance. Similar construction was underway at the Kamenka, or Dnieprodzerdzinsk factory.

8. Locomotives were almost exclusively built at Kolomna "Parovosostroitelnye Zavody", near Moscow. These were large, SHCH-type models designed by Engineer Shchukin. Average load for these was 12 - 14 passenger cars, at a speed of 75 - 85 kilometers per hour. Prior to World War II, great efforts were made in the USSR to replace steam engines with Diesels, the best model by Professor Lomonosov [fnu]. These were not successful due to extreme vibration.

9. Although small steam installations were being converted to internal combustion motors by 1941, large power stations still relied heavily on steam. Marine boilers were of Babcock & Wilson design, with a superheater on top and 22 rows of water-tubes:

Diameter	=	83 - 102 mm.
Length	=	up to 8 meters (average 4.5 - 5.5 m)
Inclination of tubes	=	1:4 or 1:5

Hot gases made two to three turns through the tubes due to high, narrow boilers. Steam superheaters were placed between the water tubes and the boiler drums. The surface of the superheater was equal to either 23% of the heating surface or 35%.

10. Factory boilers had usually 7 - 10 rows of water-tubes, their inclination equal to 1:3. Up to 300 square meters of heating surface boilers had one drum, over that they had two or three drums. Maximum pressure allowed was 15 Atm. Large factories used vertical boilers of Sterling design, with additional screening.

These had up to three drums, with powdered-coal furnaces. Drums were principally made in factories at Leningrad, Nikolaev and Magnitogorsk.

11. Boilers were well made, but broke down frequently, especially electro-central town heating systems, due to poor maintenance. Steel deteriorated rapidly due to lack of cleaning, and holes appeared in tubes, barrels and drums after a year's use.

12. Up to 1941, the Benson type boiler was of great interest to Soviet engineers. These, however, were abandoned with the advent of gas generators working on wood and charcoal. In the Benson-type boiler, water was pumped through spiral tubes, heated to 374°C, where heat of evaporation was 0, and water passed into the steam of the same volume and 224 Atm of pressure. This steam passed through the tubes of a superheater, then through a reductor, bringing it to a needed working pressure, where it is directed into the turbine. Circulating tubes and drums were not required. Tubes were small in diameter, equal to 20 - 32 mm. Efficiency coefficient of this boiler was found to be over 90%.

13. Following was a list of recommended reading for boiler engineers in the USSR up to 1941:

Eberle: Mitreisen von Wasser aus dem Dampfkessel.

Schultze: Der Derzeitige Stand der Feuerungtechnik.

Munzinger: Die Leistungsteigerung von Grossdampfkesseln.

Guilleaume: Ehrfarungen und Forderungen des Praktischen Kesselm-
betriebes.

Schak: Neuere Erkenntnisse auf dem Gebieteder Wärmestrahlung.

Tetzner und Heinrih O Dampfkesseln.

Spalkhaver P, Fritz Schneider und A. Rüster. Dampfkesseln.

P Granowskyk. "Steam Boilers".